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Models of magnetized neutron star atmospheres: Thin atmospheres and partially ionized hydrogen atmospheres with vacuum polarization

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Abstract

Context. Observed X-ray spectra of some isolated magnetized neutron stars display absorption features, sometimes interpreted, as ion cyclotron lines. Modeling the observed spectra is necessary to check this hypothesis and to evaluate neutron star parameters. Alms. We develop a computer code for modeling magnetized neutron star atmospheres in a wide range of magnetic fields (10 12-1015 G) and effective temperatures (3 x 10 5-107 K). Using this code, we study the possibilities to explain the soft X-ray spectra of isolated neutron stars by different atmosphere models. Methods. The atmosphere is assumed to consist either of fully ionized electron-ion plasmas or of partially ionized hydrogen. Vacuum resonance and partial mode conversion are taken into account. Any inclination of the magnetic field relative to the stellar surface is allowed. We use modern opacities of fully or partially ionized, plasmas in strong magnetic fields and solve the coupled radiative transfer equations for the normal electromagnetic modes in the plasma. Results. Spectra of outgoing radiation are calculated for various atmosphere models: fully ionized semi-infinite atmosphere, thin atmosphere, partially ionized hydrogen atmosphere, or novel "sandwich" atmosphere (thin atmosphere with a hydrogen layer above a helium layer). Possibilities of applications of these results are discussed. In particular, the outgoing spectrum using the "sandwich" model, is constructed. Thin partially ionized hydrogen atmospheres with vacuum, polarization are shown to be able to improve the fit to the observed spectrum of the nearby isolated neutron star RBS 1223 (RX J1308.8+2127). © ESO 2009.

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Keywords

Methods: numerical, Radiative transfer, Stars: atmospheres, Stars: individual: RX J1308.8+2127, Stars: neutron, X-rays: stars